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US

(54) NONREFLECTING FLATTENING LAYER FOR SILICA BASE BODY

(57)Abstract:

PURPOSE: To obtain a dyed spin-on glass compsn. having a high carbon content to be used to form a nonreflecting flattening layer on a substrate such as a semiconductor silicon wafer.

CONSTITUTION: The spin-on glass compsn. contains a polyorganosiloxane polymer soln. which is crosslinked and contains an org. dye showing stable absorption of light at 350 to 500°C. The polyorganosiloxane polymer contains at least 30atm.% carbon and aminoorgano trialkoxysilane. The alkoxy groups have 1 to 4 carbon atoms. The obtd. layer can be used as a hard mask by etching according to a pattern formed on the layer. The hard mask can be used as a multilayer resist and used for the production of a lithography mask.

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Summary.

(57) [Abstract]

[Objects of the Invention] It is the dyed spin-on glass constituent with a high carbon content which is used for giving an un-reflecting nature planation layer on substrates, such as a semiconductor silicon wafer.

[Elements of the Invention] This spin-on glass constituent contains the polyorganosiloxane polymer solution containing the organic dye which absorbs light which constructed the bridge. This polyorganosiloxane polymer contains the carbon of 30 atomic-weight %, and an amino ORUGANOTORI alkoxy run at least. This alkoxy group has the carbon atom of 1 or 4.

[Effect] These layers can use the pattern prepared in this as a hard surface mask blank by

*****ing. These hard surface mask blanks can be used as a multiplex layer register strike, and are applicable to creation of a RITOGURA fee mask.

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CLAIMS

[Claim(s)]

[Claim 1] The dyed spin-on glass constituent which is characterized by being the dyed spin-on glass constituent containing a solution with the color of a bridge formation polyorganosiloxane and optical-absorption nature stable at 350-degree-C-500 degree C, for this polyorganosiloxane containing the carbon of 30 atomic-weight percent, and an amino ORUGANOTORI alkoxy run at least, and this alkoxy group containing the carbon atom of 1-4.

[Claim 2] The hard surface mask blank to which it is the hard surface mask blank which contains an un-reflecting nature flat-surface layer on a substrate, and this un-reflecting nature flat-surface layer is characterized by being exposed among two or more portions of this un-reflecting nature flat-surface layer to which it was guided from the spin-on glass which the claim 1 dyed, and two or more places of this substrate carried out the schedule pattern.

[Claim 3] The method of manufacturing a hard surface mask blank characterized by providing the following. (a) The constituent deposit step to which are the step which carries out the laminating of the silica base-material layer of the shape of an un-reflecting nature flat-surface layer guided from the dyeing spin-on glass constituent on a substrate, this polyorganosiloxane contains [this dyeing spin-on glass constituent] the carbon of 30 atomic-weight percent, and an amino ORUGANOTORI alkoxy run at least including the solution of a bridge formation polyorganosiloxane and an optical-absorption nature inorganic dye, and it was made for this alkoxy group to have the carbon atom of 1-4. (b) The step which deposits a uniform photoresist matter layer substantially on this silica base-material layer. (c) The step which irradiates light in the shape of a schedule pattern at two or more portions of this photoresist layer. (d) The step

which removes the portion distinguished by this optical irradiation, and develops this photoresist to make it openly [portions / two or more / of a lower layer silica base-material layer / begin], and the step which etches a part for this outcrop of a lower layer silica base-material layer that a lower layer substrate should be substantially exposed in the shape of [same] a pattern with the portion by which (e) this photoresistor strike was this irradiated.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the application liquid which gives the un-reflecting nature flat-surface layer used for the photolithography processing in manufacture of a semiconductor device. Since the etch rate is smaller than an ordinary photoresistor strike, this layer functions as a hard surface mask blank for plasma etching.

[0002]

[Description of the Prior Art] The need for development of the device equipped with the multiplex metal layer has made it urgent as the request of wanting to realize a more nearly high-speed integrated circuit increases. Use of the planation matter layer for carrying out planation of the uneven geographical feature on a substrate to these development, and making into the minimum thickness change of the photoresistor strike matter layer overlaid after that is indispensable. The size of a device takes the need of giving the photoresistor strike matter layer of a uniform layer, for becoming small, and it is increasing.

[0003] The geographical feature of a lower layer substrate may cause optical interference in photolithography processing by reflection of a photon. In order to prevent reflection of an irradiation beam, the acid-resisting paint has been used. In order to prevent the resolution loss which originates in reflection from a substrate in this acid-resisting layer, including a color is

performed conventionally.

[0004] By the conventional method, planation and acid resisting are given by the separate layer. An organic nature planation layer is used especially by the photolithography method. This is because a planation layer must be able to carry out the pattern transfer of the pattern of the photoresist layer of the best layer good in a lower layer. U.S. Pat. No. 4557797 [else / forward-looking infrared] / is indicating use of the poly methyl meta-KURIRATE planation layer. U.S. Pat. No. 4621042 [else / loan / Pampa] is indicating use of an ORUTOKURE SOL novolak resin for the planation on the front face of a semiconductor. Since it is often difficult to dissolve the suitable color for an organic planation layer, the separate layer which contained the color until now is used as an acid-resisting paint. Usually, the organic composition containing the color is used as an acid-resisting ointment.

[0005] Then, it is desirable to give the constituent which can manufacture the layer which achieves both planation and an optical absorption.

[0006] The spin-on glass (spin-on glass, glass which carried out rotation molding) constituent is used as a planation layer in the case of carrying out other various processings, such as using it as an insulating layer between metallic-circuit networks. This constituent is applied to a semiconductor wafer, and it rotates, and it dries and it forms a solid-state layer. then, if this layer is hardened at an elevated temperature, it will form the layer (henceforth a silica base-material layer) which makes a hard (glass -- it needs) silica a base material

[0007] In spite of having tried composition various about a spin-on glass component, much limits exist in manufacture and use of most spin-on glass constituents. The availability as a planation layer of these constituents should especially be restricted to damage on the front face by processing since then, adhesive poverty, and the shortness of an inventory permission period. The thickness limit by the brittleness of a spin-on glass layer is also pointed out.

[0008] Another limit of the spin-on glass constituent in the case of using as a planation layer for photoresists is that it is difficult to control the plasma etching speed of this layer. For this reason, when imprinting a pattern from the photoresistor strike layer of the best layer to a lower layer metal layer, a crevice and a deficit occur, and loss of pattern resolution is caused.

[0009]

[Problem(s) to be Solved by the Invention] Then, this invention makes it a technical problem to give the spin-on glass constituent which gives the un-reflecting nature planation layer which can be used for photolithography processing.

[0010] Another technical problem of this invention is giving the method of generating the pattern suitable for processing since then to the layer obtained from such a constituent.

[0011] Still more nearly another technical problem of this invention is giving the hard surface mask blank containing the pattern layer (patternized layer) obtained from the spin-on glass constituent of this invention.

[0012]

[Means for Solving the Problem] The spin-on glass constituent of this invention contains the polyorganosiloxane polymer solution containing the organic dye which absorbs light which constructed the bridge. This polyorganosiloxane polymer contains the carbon of 30 atomic-weight %, and an amino ORUGANOTORI alkoxy run at least. This alkoxy group has 1 or 4 carbon atom.

[0013] The method of forming a pattern layer on a semiconductor substrate is also given by this invention. That this method carries out the laminating of the metallic-conductor layer on the semiconductor substrate which has partial structure, and carrying out the laminating of the spin-on glass layer of sufficient thickness to give the non-reflecting surface of a plane substantially on this conductor layer are included. This spin-on glass layer is obtained from the constituent of this invention here. Subsequently, the laminating of the photograph REJITO material is carried out on the spin-on glass layer. Into two or more portions of this photoresist, light is irradiated, and is developed, the portion is removed, and a lower layer conductor-material portion is exposed. Subsequently, the portion to which the spin-on glass was exposed is *****ed and a lower layer conductor-material portion is exposed.

[0014] The hardware mask of this invention contains a substrate and the pattern of the silica base-material layer obtained from the spin-on glass constituent of this invention. This base-material layer is patternized by *****ing a part for the outcrop.

[0015]

[Example] The dyeing spin-on glass constituent of this invention is the solution of the polyorganosiloxane containing a color which constructed the bridge. This polyorganosiloxane contains the carbon and the silane fixing agent of 30 atomic-weight % at least. As a color, titanium oxide Cr 2O₃ and an inorganic dye like MoO₄, MnO₄, and ScO₄ are desirable. The reason is that these stop also at the temperature exceeding 90 degrees C stably. An organic dye becomes less stable when a spin-on glass is generally hardened at 350 degrees C or 500 degrees C. The weight ratio of a color to polymer is about 0.5:1 or 3.5:1.

[0016] In order to include a high carbon content into polymer, the principal chain of the polyorganosiloxane over which the bridge was constructed is guided from the mixture of an alkoxy run, the part or all -- an organic machine -- it is preferably replaced by the C1-C4-alkyl group and the phenyl group. This carbon content is determined by the number of organic substitution AKUKO xylans contained in a polymer chain.

[0017] Desirable substituents are a methyl group and a phenyl group. These substituents show high binding energy with a silica, and while a spin-on glass layer hardens, even if it is exposed to an elevated temperature, they do not decompose it. An ethyl group, a propyl group, and other alkylation machines like a butyl can be adopted when [which can avoid this decomposition] it can case or ignore.

[0018] It is and the desirable polyorganosiloxane (henceforth a bridge formation polyorganosiloxane) which carried out [aforementioned] bridge formation has both a methyl group and a phenyl group as a substituent in the example. As for the spin-on glass constituent which has only a phenyl group on siloxane polymer, etching gives a difficult layer by the conventional etching system. As for the ratio of a methyl group pair phenyl group, it is desirable that it is in the range of 1:1 or 1:3. It is most desirable that some silica atoms in the polyorganosiloxane which constructed the bridge have both the methylation machine combined with this and a phenyl substituent. This can be attained by guiding a bridge formation polyorganosiloxane from a methylphenyl AKUKO xylan. Such a bridge formation polyorganosiloxane gives an application layer with the resistance which was excellent to cracking in subsequent processing.

[0019] That an organic component content is high contributes to the fall of the amount of silanols in the bridge formation polyorganosiloxane used into the dyed spin-on glass constituent, and the fall of an alkoxy amount. The amount of silanols makes an alkoxy amount preferably less than 0.1 % of the weight less than 1.4% of the weight. The lowness of these values also originates in the bridge formation in polymer.

[0020] The carbon content of the polyorganosiloxane which constructed the bridge can be determined in heat gravity analysis (thermal gravimetric analysis). This analysis method is performed by heating the sample of a fixed weight slowly within a thermal-analysis meter, and decomposing. Next, it is decided that it will be the amount of the organic substance which had the difference acquired in the weight which remains at the beginning as compared with the weight lost.

[0021] A silane fixing agent is contained in the bridge formation polyorganosiloxane used for the dyeing spin-on glass constituent by this invention. These silanes are known well in the industrial world to improve the adhesiveness between inorganic media, such as an organic resin, glass and sand, or a filler. These silane fixing agents have two molds in a substituent. One is the organic functional group coupled directly with the silicon atom, and another is the organic machine of C1-C4-aceto oxy-** combined through oxygen. It permits that alkoxy one of these / acetoxo groups include a silane into the polyorganosiloxane which constructed the bridge. As for an organic functional-group silane, it is desirable to have three C1-C4-alkoxy groups, and, as for ethoxy ****, it is [them] most desirable that it is a methoxy machine.

[0022] The silane fixing agent marketed is an amino organic organic-functions group, a ureido organic functional group, or a glycidic oxy-organic functional-group group. An amino ORUGANOTORI (C1-C4) alkoxy run is desirable. as the example -- gamma-aminopropyl-TORIE -- an ibis -- a silane, a gamma-aminopropyl trimethoxy run, and N-beta (aminoethyl)-gamma-aminopropyl TORIE -- an ibis -- there are a silane and an N-beta (aminoethyl)-N-beta (aminoethyl)-gamma-aminopropyl trimethoxy run the most desirable organic functional-group

silane fixing agent -- gamma-aminopropyl TORIE -- an ibis -- it is a silane

[0023] An amino ORUGANOTORI (C1-C4) alkoxy run has the desirable thing of the polyorganosiloxane which constructed the bridge included about 10 to 50% of the weight. Content of this level gives remarkable bridge formation. In this way, the feature of the polymer obtained is the polyorgano silsesquioxane (polysilsesquioxane) polymer resulting from bridge formation-ization. The bridge formation organopolysiloxane used for the spin-on glass constituent of this invention can have a KONSHISU tensile building with the "cube octamer (cubical octamer)" structure, the double chain "ladder (ladder)" structure, or its both. others [Barry / A JIE] -- "an inorganic polymer" (a stone and GURAHAMU edit, New York State Academic Press, the 1962 issue, 195 pages) -- such structures are explained to Chapter 5 These are carrying out complicated structure originating in the 3 functional-group nature of a thoria RUKOKI silane which has the organic group of ***** in each silicon atom. Although a tetrapod alkoxy run and a JIORUGANO alkoxy run can be included in these polymer, polymer is guided from most portion and a 3 organic-functions silane.

[0024] The weight average molecular weight of the bridge formation polyorganosiloxane polymer used for the dyeing spin-on glass constituent of this invention is about 2000 or about 20000 or more ranges. The only limit about polymer molecular weight is that the viscosity of the solution formed in order to allow the uniform application polymer must be able to dissolve in an inactive organic solvent must fully be low.

[0025] They are a solution-like, as for the polyorganosiloxane and color which constructed the bridge in the spin-on glass constituent which this invention dyed, it is desirable that the weight ratio of the total amount of solid-states is concentration 5 or 40 % of the weight, and it is most desirable that it is 5 or 20 % of the weight. Monochrome hide rucksack alcohol, poly hide rucksack alcohol, and a glycol ether are contained in a suitable solvent. Next, what is hung up is the example of suitable monochrome hide rucksack alcohol. 1-butanol, 2-butanol, 2-methyl-1-propanol, a 2-methyl-2-propanol, and 1-phenol. Suitable poly hide rucksack alcohol and suitable oligo MERIKKU alcohol are ethylene glycol monoethyl ether, a diethylene glycol monoethyl ether, triethylene-glycol monoethyl ETERUPUROIPIRENGURIKORUMONO ethyl ether, the dipropylene-glycol monoethyl ether, and the dipropylene-glycol monomethyl ether. The mixture of these alcohol is also suitable. These alcohols are also suitable. In order to dry, the inactive organic solvent should have less than 250 degrees C and the desirable boiling point higher than 80 degrees C. Use of N-butanol and an isopropyl is desirable.

[0026] the spin-on glass constituent which this invention dyed -- an PH -- the range of 3 or 7 -- it is in the range of 6 or 6.7 preferably An acid PH is given with an organic acid or a hydrogen peroxide. A desirable acid is an acetic acid. As for the viscosity of the dyed spin-on glass constituent, it is desirable at the time of 5 or 20% of the weight of solid-state content that it is in the range of about 3.5 or 9 centistokes. A multiplex application is needed, in order to obtain a

thick spin-on glass layer, if viscosity is too low. It becomes difficult to attain uniformity, in case a substrate will be applied, if viscosity is too high.

[0027] The dyeing spin-on glass constituent of this invention is stable. That is, viscosity does not increase under ambient temperature over one years or more.

[0028] The above-mentioned spin-on glass constituent by this invention is prepared by dissolving the polyorganosiloxane which contains at least 30% of the weight of carbon in an organic solvent. This solvent is desirable and the boiling point is less than 250 degrees C, desirable monochrome hide rucksack alcohol higher than 80 degrees C, poly hide rucksack alcohol, or a glycol ether. A suitable solvent kind is the above-mentioned thing. N-butanol and isopropyl alcohol are desirable.

[0029] The polyorganosiloxane with a high carbon content is obtained by KOHIDORO-izing the mixture of alkoxy runs. With an organic machine, it is a C1-C4-alkyl group and a phenyl group preferably, and some of ARUKOKISORAN or all is replaced. As a precursor of the polymer in the spin-on glass constituent of this invention, these polyorganosiloxanes contain the methyl and phenyl substitution product of request level. Therefore, as for the ratio of a methyl pair phenyl, in the above-mentioned bridge formation polyorganosiloxane, it is desirable that it is the range of 1:1 or 1:3. Furthermore, these polyorganosiloxanes contain the silicon atom which both the methyl and the phenyl group combined.

[0030] Alignment is sufficient as the polyorganosiloxane used for the method of this invention, and as long as it can stop at poly silsesquioxane polymer, it may have the remarkable number of bridge formation. As long as they can be dissolved in an inactive organic solvent, there is no limit about structure and molecular weight.

[0031] Two or more polyorganosiloxanes can be used in the method of this invention of giving a spin-on glass constituent. However, it is desirable not to use mixture in order to guarantee consistency structure.

[0032] this polyorganosiloxane -- carrying out -- no-***** is low Since this has the high amount of organic components, it is because the degree of cross linking is high depending on the case. A silanol content is less than 13 % of the weight, and it is preferably desirable for a bitter taste KOKISHI content to be less than 10 % of the weight.

[0033] The carbon content in a desirable poly methylphenyl siloxane is the range of about 40 to 50 atomic-weight %. However, a polyorganosiloxane with a higher carbon content is also suitable.

[0034] the dissolved polyorganosiloxane -- the bottom of a bitter taste potash state -- setting -- a silane fixing agent -- desirable -- an AMINOO luganot tree (C1-C4)-alkoxy run -- most -- desirable -- gamma-aminopropyl-TORIE -- an ibis -- it reacts with a silane An amino ORUGANOTORI (C1-C4) alkoxy run does not need to add a base material in a solution, and is fully alkaline. When it is non-alkalinity, in order that this silane fixing agent may promote a

reaction, introducing an volatile organic amine is expected. As for the PH of this reaction medium, it is desirable that it is nine or more.

[0035] The amount of this polyorganosiloxane and the silane fixing agent which reacts can reach far and wide very much. However, it is desirable to make the weight ratio of a silane to a polyorganosiloxane into the range of 0.11:1 or 1:1.

[0036] The PH of the above-mentioned reaction medium is decreased [to slow down a reaction] to stagnate at the time. It depends for reaction time on a reaction rate. A reaction rate is influenced with temperature and a pressure. The reaction which advances at a room temperature for 2 hours or more is effective in generation of a spin-on glass constituent.

[0037] Less than seven should be made to spread an PH on reducing a reaction substantially, and it should carry out to 3.0 or more, and if it carries out like this, hydronalium-ization which makes an acid a catalyst will progress. The range of a desirable PH is 5 or about 7, and is 6 or 6.7 most preferably. This can be attained by adding organic acids, such as an acetic acid or a hydrogen peroxide. Use of an acetic acid is desirable.

[0038] Once a reaction is stopped, it is desirable to ripe the constituent concerned for about one week preferably before use. Moreover, it is desirable to remove all the precipitate that filtered the solution with submicron filters, such as a 0.2-micron Teflon filter, and was formed into the reaction. If it carries out like this, this constituent will stop at stability during the period of 1 or more after that.

[0039] Before performing a reaction with a fixing agent, it can add in a solution, and a color can be added after an organic acid or a hydrogen peroxide.

[0040] The spin-on glass constituent which this invention dyed can be applied to a substrate with the conventional spin application technology, and rotates a substrate (wafer) by 1000 or more rpm in that case to produce the uniform layer of a spin-on glass constituent. The arbitrary well-known methods including the spin method, a roller-coating method, the immersing-raising method, a spray method, screen printing, and the method of the brush method and others can be used suitably. as a suitable substrate -- a semiconductor, a silicon wafer, a glass plate, a metal plate, and others -- there is a thing similar to this

[0041] Layer thickness can be changed by changing the viscosity of this spin-on glass constituent. The un-reflecting nature planation layer which exceeds 500A by multiplex application can be obtained. Subsequently to about 200 degrees C a spin-on glass constituent heats a wafer, and is dried. After an application layer is dried, the applied substrate is heated to about 350-degree-C temperature of -500 degree C, stiffens a spin-on glass application layer, and forms a smooth un-reflecting nature planation layer. When it once dries, as for the dyed spin-on glass constituent, it is desirable that shrinkage characteristics are small. Although about 15% of contraction is permissible in the vertical (perpendicular) direction, it is desirable to suppress contraction to about 10% or less. this -- a book -- it is easily obtained in the

desirable example

[0042] The dyeing spin-glass constituent of this invention can give an un-reflecting nature planation layer 5000A or more, without being able to give an un-reflecting nature planation layer 500A or more, and causing cracking or a deficit in subsequent processing.

[0043] The un-reflecting nature planation layer given with the dyeing spin-on glass constituent of this invention shows the very strong resistance over oxygen, while etching by CHF₃ and O₂. This resistance is remarkable especially when the polyorganosiloxane which constructed the bridge contains many phenyl groups.

[0044] The dyeing spin-on glass constituent of this invention gives the hard surface mask blank which can be patternized again by carrying out plasma etching of the schedule field of this constituent layer. These hard surface mask blanks can form a part of multiplex resist for patternizing lower layers, such as a conductive layer. Moreover, these layers can also be given on a transparent substrate as preparation which gives a lithograph graphic mask.

[0045] The multiplex layer resist arranged on one layer which should be patternized is made only with the hard surface mask blank and photoresist layer chisel which are given with this dyeing spin-on glass constituent. It is desirable to place an interlayer between a hard surface mask blank and its lower layer or between photoresist matter. Another spin-on glass constituent is suitable for an interlayer.

[0046] A hard surface mask blank is obtained by first carrying out the laminating of the silica base-material layer guided from the dyeing spin-on glass constituent of this invention on a base. As for this layer, it is desirable to have a flat top front face substantially. The laminating of the layer of the uniform photoresist matter is substantially carried out on this silica base-material layer. Subsequently to, this photoresist can irradiate light in the shape of a schedule pattern, removes the portion and is developed that a lower layer silica base-material layer should be exposed. Subsequently, a part for the outcrop of this silica base-material layer is *****ed with plasma until a lower layer substrate is exposed to the shape of a pattern of the aforementioned schedule pattern and real isomorphism formed in the photoresist.

[0047] The exposed region of a lower layer substrate can be carried out if processing of etching etc. is subsequently still more nearly required. If processing is completed, a hard surface mask blank will be removed by etching with O₂ plasma, when typical. Since a silica base-material layer is resistant to etching and the speed of etching can be controlled, pattern deficits are merely few.

[0048] The example of example 1 dyeing spin-on glass constituent dissolved 52g poly methylphenyl siloxane polymer in 800ml N-butanol. This polymer came to hand by the piece of a solid-state from Illinois Owen. The amount of silanols of polymer was about 13 % of the weight or 14 % of the weight, and the ethoxy amount was about 8 % of the weight. Having been more than 40 atomic-weight % was determined in the heat gravimeter analysis of an

initial sample. In this analysis, after the sample measured the weight, it was heated to 600 degrees C at a rate of 2 degrees C/m, and it was cooled at the same speed to ambient temperature. The amount of remains was measured after cooling and the loss weight was determined as the carbon content. Although the aluminum oxide of a certain amount was heated with the resin sample, it was shown by heat gravimeter analysis that there is neither weight loss nor gain.

[0049] The polyorganosiloxane was dissolved in N butanol within 30 minutes. then, 7.2ml gamma-aminopropyl TORIE -- an ibis -- while the silane agitated within 1 minute, it was added with the pipet It carried out and the run was distilled from the silane solution currently sold with the sign of A1100 from Union Carbide. This solution was maintained at the constant temperature in a reaction period (23 degrees C). This solution continued being agitated for about 8 hours, and the 7.0ml acetic acid (electronic grade) was added after that. Precipitate was formed into the solution.

[0050] The PH fell to about 6.5 after acetic-acid addition. About 40g Ti (IV) butoxide was added by this solution. This Ti changes to TiO₂ in a solution. This solution riped for one week, was filtered to 0.2 microns with the Teflon filter after that, and removed precipitate. The solid-state concentration of this solution was about 6 % of the weight, and viscosity was about 4 centistokes. The silanol content was about 1.5% and the alkoxy content of the generated poly methylphenyl silsesquioxane polymer was less than 0.1%.

[0051] Spin-on glass layer: About 1g solution was applied to the silicon wafer with a diameter of 4 inches. This wafer rotated for about 3 seconds by speed 1000rpm on the spinner, and, subsequently rotated by 4500rpm for about 30 seconds. A constituent has neither formation of a bubble, nor bulging, and has applied the wafer uniformly. Subsequently, this wafer was moved to the ellipsometer (Ellipsometer) and thickness and the refractive index were determined by several places of a wafer. The refractive index was the average 1.5 [about] as a typical value, and average thickness was about 1500A. Following this measurement, the wafer was moved to the hot plate and heated by about 200 degrees C for about 1 minute for application layer dryness. Application layer thickness and the refractive index were again measured by the ellipsometer, and the contraction of the vertical (perpendicular) direction was calculated. Less than about 10% of this was typical.

[0052] The multiplex layer application was repeated until it made it total thickness and became 4000 or the range of 10000A.

[0053] When desired thickness was obtained, the wafer was moved to the tubular furnace and heated by about 400 degrees C in nitrogen atmosphere for 60 minutes. Subsequently, the center of a wafer was measured by the ellipsometer, the refractive index of a wafer was measured, and thickness was measured by nine places. Let the averages of these values be application layer thickness and a refractive index. As for a refractive index, about 1.49 is

representation ****. It suited within the limits of 4000 or 9000A. The cracking crack or the pinhole were not detected at all by the application layer. An application layer has the almost same etch rate as the film containing the same siloxane polymer without a color. The etching method performed in such a spin-on glass layer is illustrated below.

[0054] etching method: -- what does not contain a color with the silica base-material film prepared by the above-mentioned method -- the inside of AME8110 "a rear KUEIBU ion etcher" of an applied material company -- CHF3 and O2 -- etching -- the bottom The etch rate of these films is almost the same as that of the case of the film containing a color. The rate of an oxygen flow rate was changed and the etch rate was determined about many samples. The etch rate of the silica base-material film obtained from the spin-on glass constituent (color content is not carried out) of two marketing also changed the rate of an oxygen flow rate, and was determined. These results are summarized to the following tables:

[0055]

table 1 Etch rate (a part for angstrom/)

----- Rate of O2 flow rate This example * ACC1 108 ACC2 110 SCCM
(300 degrees C) (425 degrees C) (425 degrees C)

----- 4 150 5 120 175 6 60 7 190 225 8 75 9280 350 10 110 13 160 15
220 17 225 ----- Note 1 Acc 108 = color. Accuglass 108 (ARAIDO

chemical company) which is not contained

notes 2 Accuglass 110 (ARAIDO chemical company) which does not contain an Acc 110 = color

* This film does not contain a color.

[0056] The data of Table 1 show that it has high resistance even if it changes an oxygen density variously, when the silica base-material layer manufactured with the constituent of this invention etches by CHF3.

[Translation done.]